

Gardening for Monarchs and Pollinators



Fátima Matos

Presentation Outline

- My interest in gardening with native plants
- Plant natives: Garden transformation
- Milkweed and Monarchs: co-evolution of monarchs and milkweed plants
- Native plant diversity in the garden to attract a diversity of pollinators

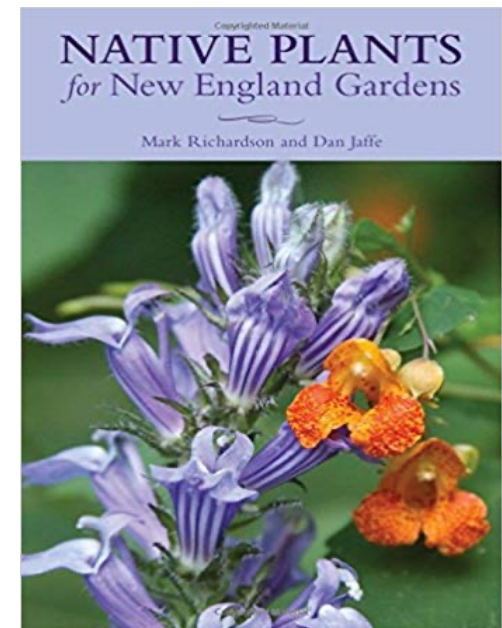
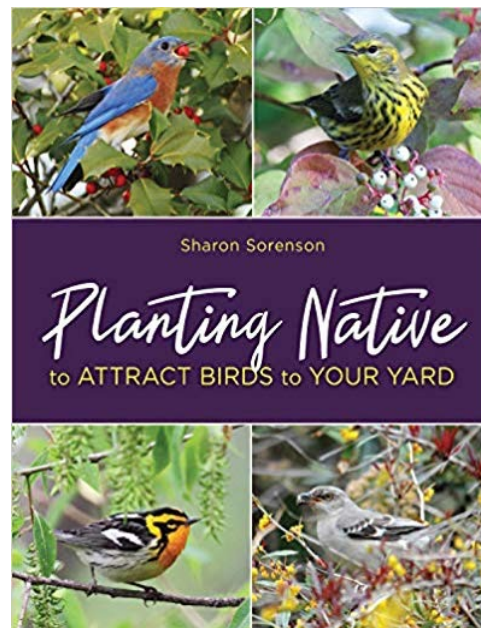
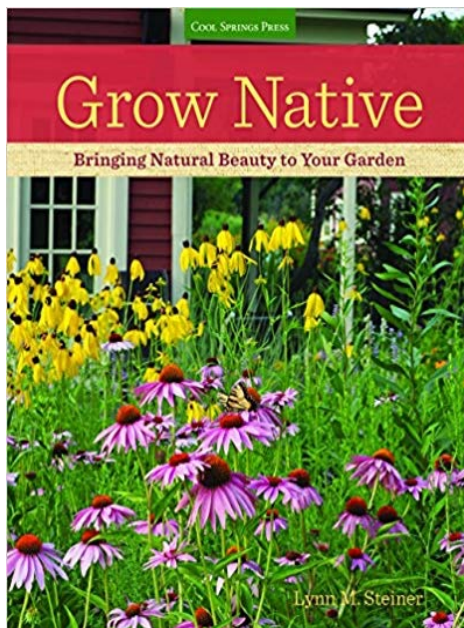
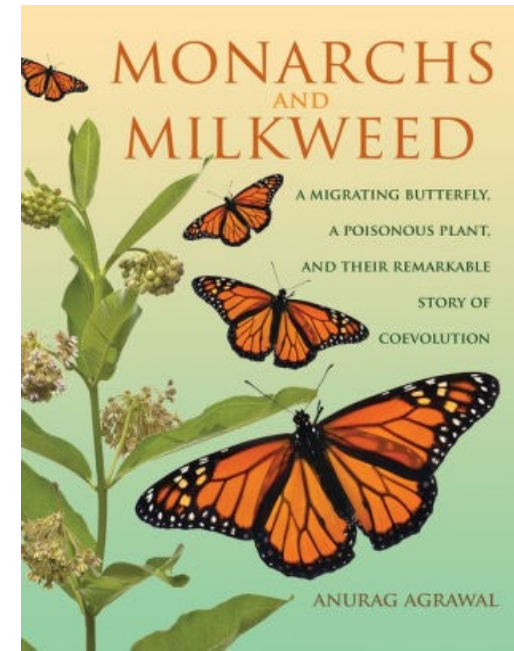
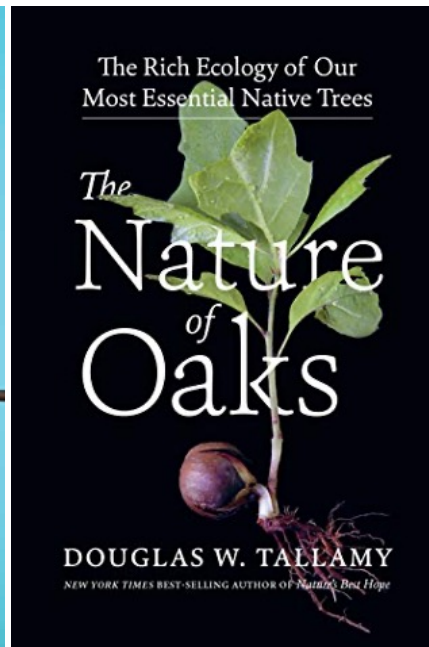
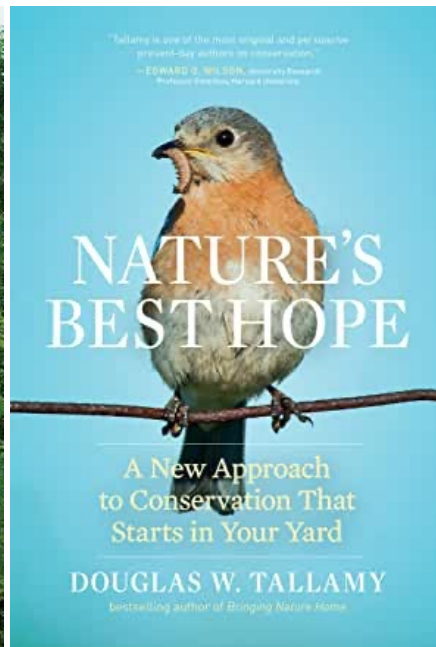
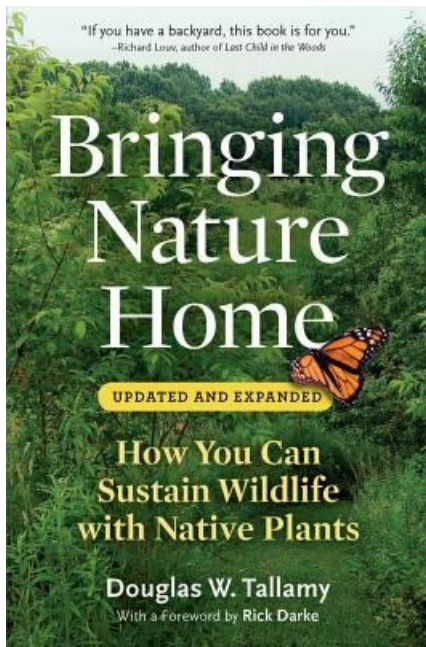
All photos (taken by F. Matos) and observations (insects seen in my garden to date) were made in the back and front yards of my home in Mystic, CT.

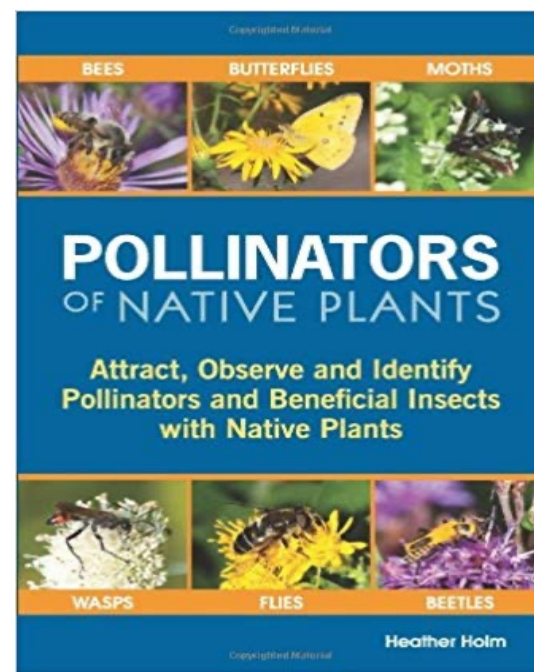
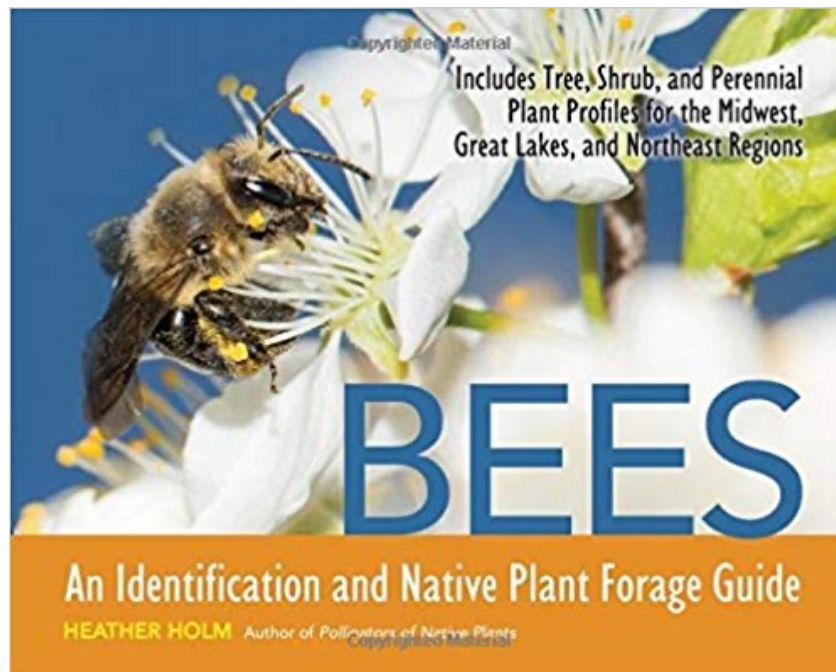
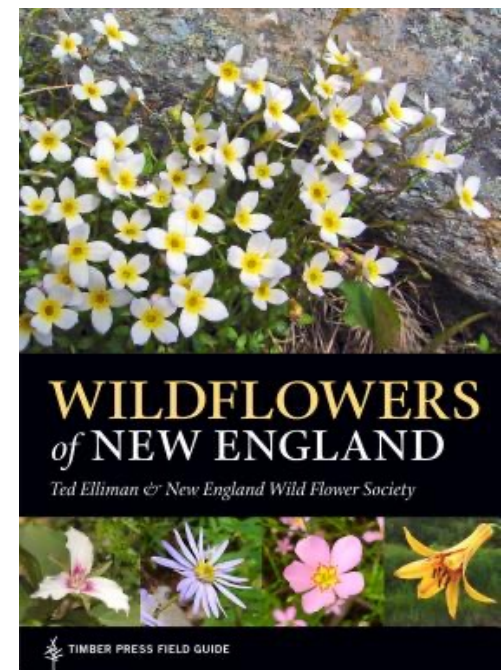
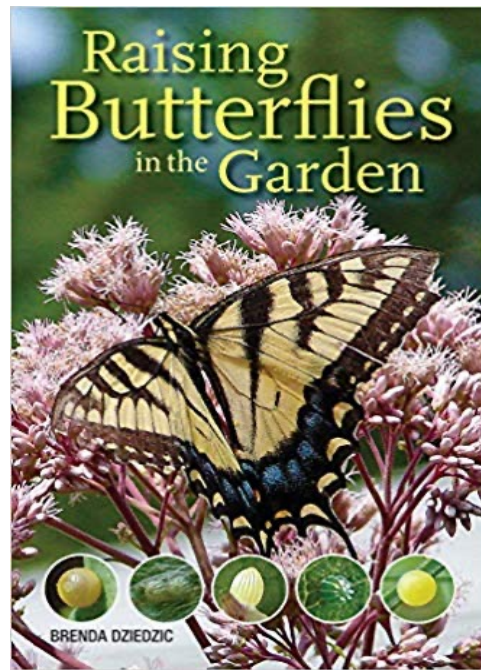
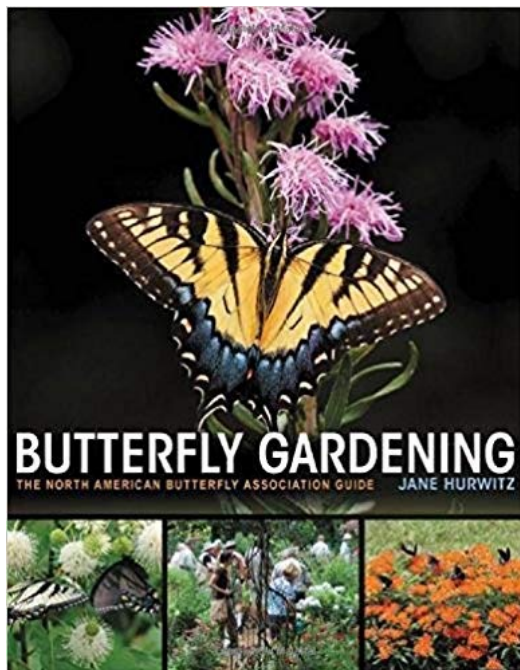
My interest in native gardening: why native plants?

- Decline of insect population, including monarchs
- Love nature, birds and butterflies
- Was not aware of the key role of native plants for pollinators
- ‘The inspiration’ to plant native plants: a visit to a friend’s garden with much butterfly activity and continuous ‘buzzing’
- But... what are/how/where to get native plants?
- Homework: Books, WildOnes programs, CT College/DPNC walks, friends/others with native plant expertise

by Douglas W. Tallamy

by Anurag Agrawal





What did I learn?

- Remove invasives and replace with native plants (started planting Spring 2018, now have ~150 native plant species)
- Plant a *diversity* of plants to attract a *diversity of 'visitors'* (bees, beetles, wasps, butterflies, moths, birds)
- Must have both *host plants* for caterpillars and *nectar plants* for adult butterflies
- Welcome the 'debris look': leaves, old wood, some bare ground areas to attract a diversity of insects (~70% of native bees dig little burrows for rearing young)
- Needless to say: NO herbicides, NO pesticides!
Not even away from pollinator gardens: these chemicals drift

Early Summer 2018 – A young garden but

Transformation

With beautiful flowers and insects!

View of garden borders (Summer 2018)



View of garden borders (Summer 2019)



Looking more like a native garden (Summer 2019)



View of garden borders (Summer 2020)



View of one of the borders (Sept 2020)



Asters

Goldenrods

Agastache

09/20/2020 13:58
Mountain mint

View of garden borders (Aug 2021)



A pollinator garden: 'If you plant they will come'



Top Pollinators

Eastern carpenter bee (Xylocopa virginica) & Two-spotted bumble bee (Bombus bimaculatus)
Great Black Digger Wasp (Sphex pensylvanicus) & Great Golden Digger Wasp (Sphex ichneumoneus)

Other Top Pollinators



Swamp milkweed

Snowberry Clearwing moth (*Hemaris diffinis*)



Clubbed Mydas fly
(*Mydas clavatus*)



Pollinators: wasp, bee, moth, ants and the 'buzzing' on swamp milkweed (*A. incarnata*)



Monarch butterfly on butterfly milkweed (*A. tuberosa*) Monarch caterpillar on red milkweed (*A. incarnata*)

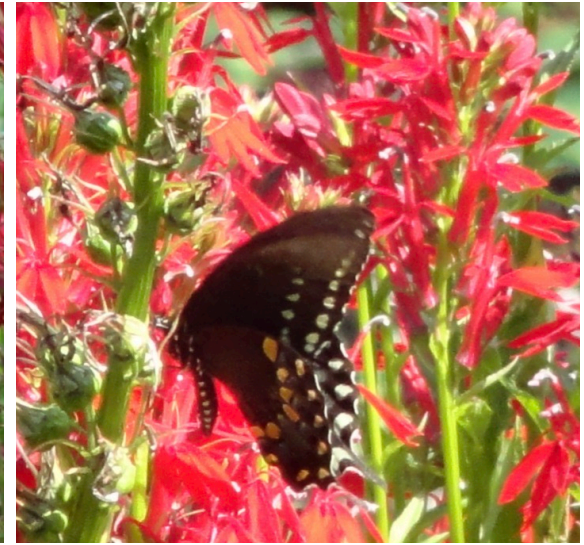
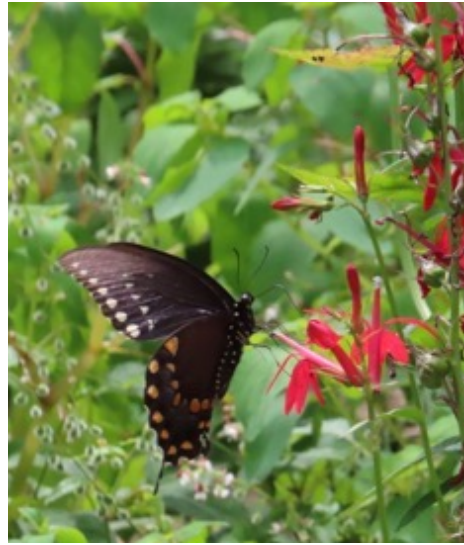
Monarch (*Danaus plexippus*)

Family: Nymphalidae (Brushfoots)



Spicebush Swallowtail (*Papilio troilus*)

Family: Papilionidae (Swallowtails)



Eastern Tiger Swallowtail (*Papilio glaucus*)

Family: Papilionidae (Swallowtails)





Painted Lady
(*Vanessa cardui*)
Family: Nymphalidae (Brushfoots)

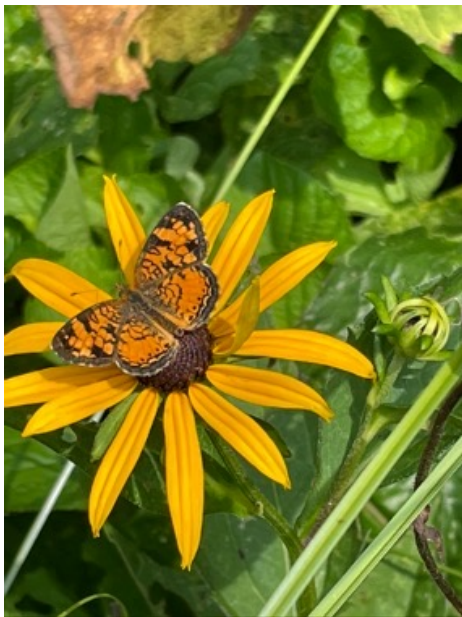


American Lady
(*Vanessa virginiensis*)
Family: Nymphalidae (Brushfoots)

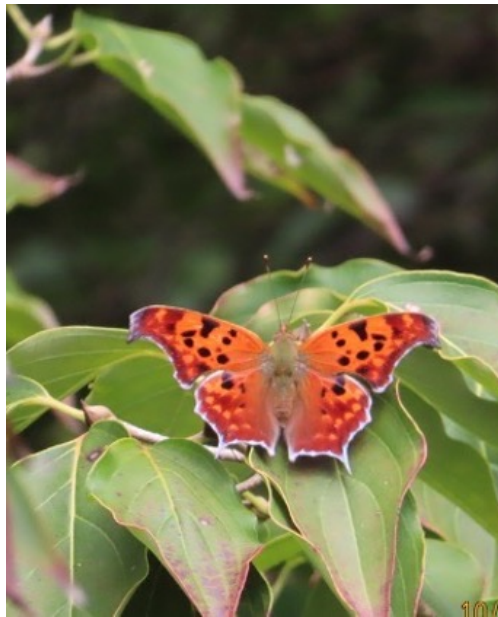


Red Admiral
(*Vanessa atalanta*)
Family: Nymphalidae (Brushfoots)





Pearl Crescent
(*Phyciodes tharos*)
Family: Nymphalidae (Brushfoots)



Question Mark
(*Polygonia interrogationis*)
Family: Nymphalidae (Brushfoots)



Great Spangled Fritillary
(*Speyeria cybele*)
Family: Nymphalidae (Brushfoots)



Little Wood Satyr
(*Megisto cymela*)
Family: Satyrinae



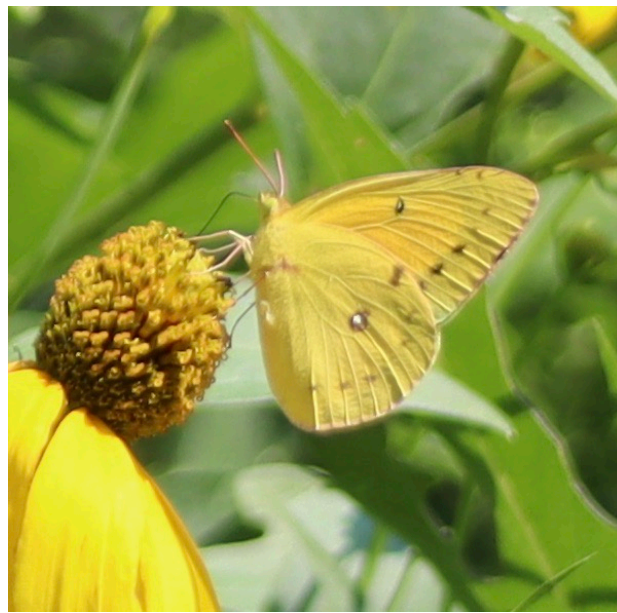
Red-banded Hairstreak
(*Calycopis cecrops*)
Family: Lycaenidae



Striped Hairstreak
(*Satyrium liparops*)
Family: Lycaenidae



American Copper (*Lycaena phlaeas*)
Family: Gossamer Wing



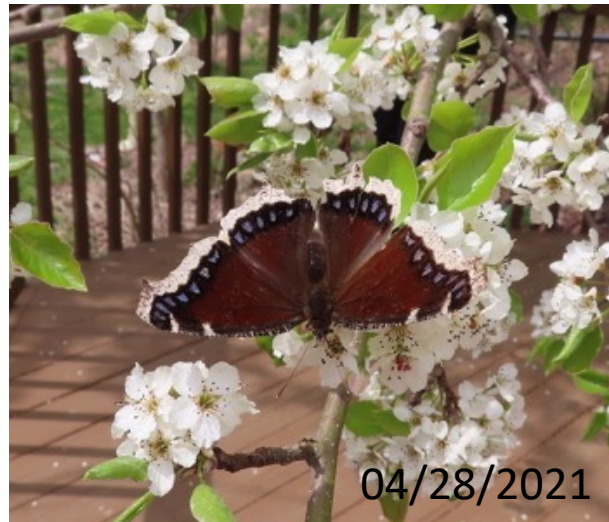
Orange Sulphur (*Colias eurytheme*)
Family: Pieridae (Yellows and sulphurs)



Cabbage White (*Pieris rapae*)
Family: Pieridae (White/Sulphur)



Mourning Cloack (*Nymphalis antiopa*)
Family: Nymphalidae (Brushfoots)



The Mourning Cloack butterfly hibernates in winter under leaves and garden debris and comes out in early Spring: a good reason to 'welcome the 'debris look'!

.... and many Skippers



Silver-spotted Skipper (*Epargyreus clarus*)
Family: Hesperiidae

Moths



Tiger Moth (*Hyphantria*)



Yellow-Collared Scape Moth
(*Ciseps fulvicollis*)



American Dagger Moth
(*Acronicta americana*)



Ailanthus Webworm Moth
(*Atteva aurea*)

Other insects...



Eastern Physocephala
(*Physocephala tibialis*)



Macrosiagon limbata



Red-banded leafhopper
(*Graphocephala coccinea*)



Acanthocephala terminal



False Potato Beetle
(*Leptinotarsa juncta*)



Japanese Beetle
(*Popillia japonica*)

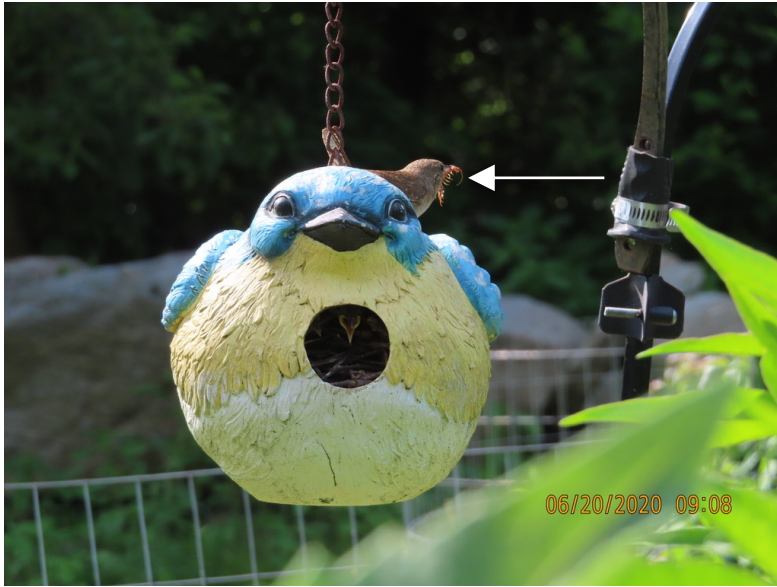
Praying Mantis (*Mantis religiosa*)

Official CT State Insect (1977)



European Praying Mantis is not native to North America, but originated in Northern Africa, Southern Europe and temperate areas of Asia. This top insect predator is “beneficial for farmers and a symbol of the importance of the natural environment”.

Habitat for nesting birds



House wren (*Troglodytes aedon*)



House wren (*Troglodytes aedon*)



Tree swallow (*Tachycineta bicolor*) Cat bird (*Dumetella carolinensis*) Black-capped chickadee (*P. atricapillus*)

House wren with food for the babies

Insect-eating birds depend on the availability of high protein, high calorie insects to feed their young: i.e. caterpillars, spiders and other insects!



New Smithsonian Study Links Declines in Suburban Backyard Birds to Presence of Nonnative Plants

Findings Give Landowners a Simple Road Map to Provide Essential Habitat to Breeding Birds *Oct. 22, 2018*

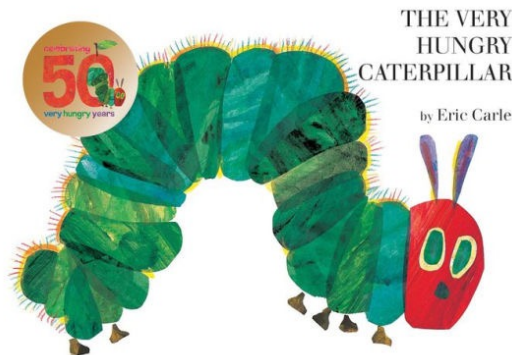


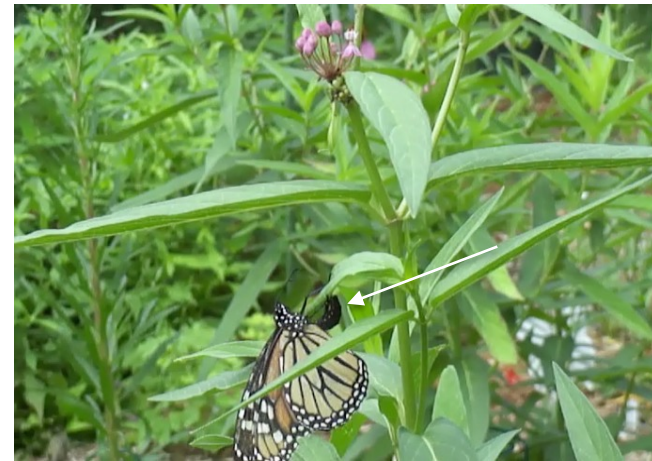
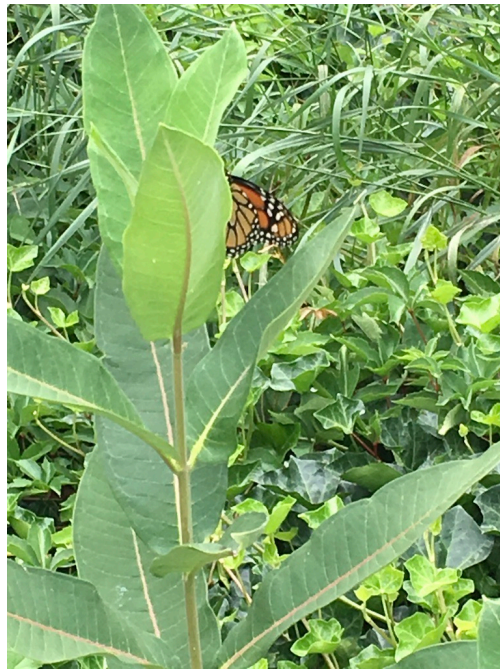
Carolina chickadees depend on the availability of high-calorie, high-protein prey, such as caterpillars, for a healthy breeding season. Backyards landscaped with even a small portion of non-native plants, however, lack the appropriate cuisine, leading to a decline in the breeding success and population growth of the bird species, according to a new SCBI study.

Photo: Doug Tallamy, University of Delaware

Monarchs and Milkweeds

- Among insects, monarch butterflies and their eggs and caterpillars are the easiest ones to see in any garden
- Monarchs are beautiful and loved by everyone
- Because of their epic migration (up to 3,000 miles!), their beauty and population decline, they have captivated our hearts
- Monarchs will visit any flower with nectar in any garden, BUT: to attract laying eggs female monarchs, a garden *must have milkweed plants*, the only host plant to feed the monarch's very hungry caterpillars...





Female Monarch butterfly behavior on milkweed plants
They rely on milkweed: once they find the plant, they 'sense'
the plant with their feet, then deposit their eggs.

Monarch laying egg (oviposition) under
red milkweed leaf (*Asclepias incarnata*)



Monarch caterpillars on milkweed plants
Common milkweed (*Asclepias syriaca*) & red/swamp milkweed (*Asclepias incarnata*)

Epic migration, predation, milkweed toxicity

- Adult monarchs migrate from North America to Central Mexico (up to 3,000 miles!)
- > 95% predation rate on monarch eggs and caterpillars by other insects: spiders, ants, wasps, stinkbugs!
- > 60% monarch caterpillars die on their first bites on milkweed leaves!
- < 10% monarch caterpillars make it to their full size!
- ... a lot of curiosity to watch up-close 'what's going on': raising monarchs inside my home or a tent in backyard (2019-2020)

Raising monarchs inside a screen tent in the backyard (Summers 2019-2020)



Eggs and caterpillars on milkweed leaves

The favorite milkweed patch to lay her eggs (Common milkweed, *A. syriaca*)



One female monarch lays many eggs (milkweed plant: *A. incarnata*)



Close-up of monarch eggs on milkweed leaf

Egg ~ 0.03 inch (= 0.8 mm)

Baby caterpillar (larva) ~ 0.1 inch (=0.24 mm), eats the egg shell

Monarch butterfly (*Danaus plexippus*) life cycle complete metamorphosis

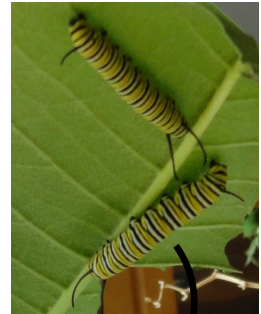
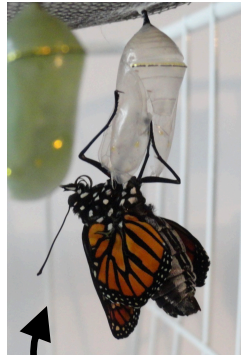
Egg on milkweed plant

4-5 days to hatch



Caterpillar (4-5 instars, final 'J')

10-14 days



Chrysalis to butterfly

10-20 days

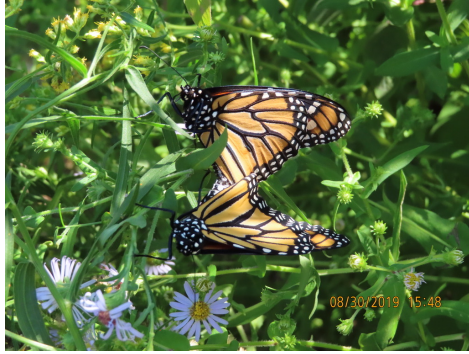
Monarch
Life Cycle

Butterfly emerges (eclosion)

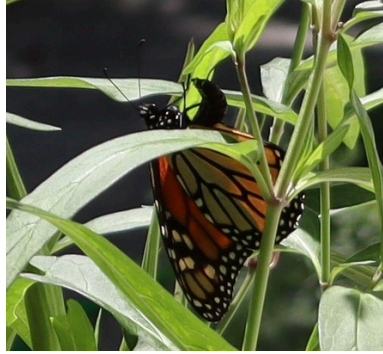
1-2 days to flying away



Mating
in air, several hours



Oviposition
tarsus sense host



Eggs
on milkweed leaf



Egg hatch
1 day old caterpillars



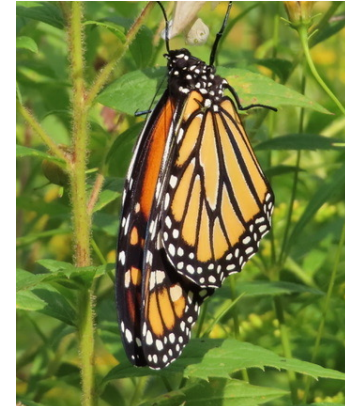
Caterpillar
molt, 4-5 instars



Caterpillar 'J' (Jay shape) and Chrysalis
silk pad to hang upside down



Adult butterfly
Eclosion

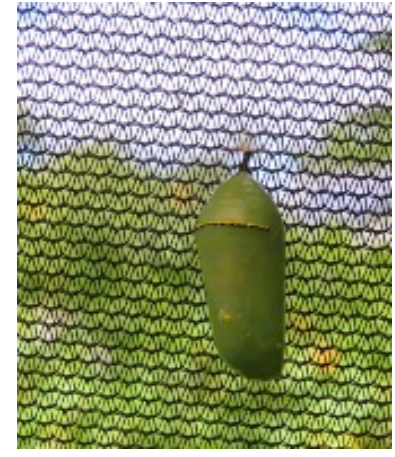


Monarch butterfly (*Danaus plexippus*) life cycle:
complete metamorphosis

The 'J' can hang at any place...



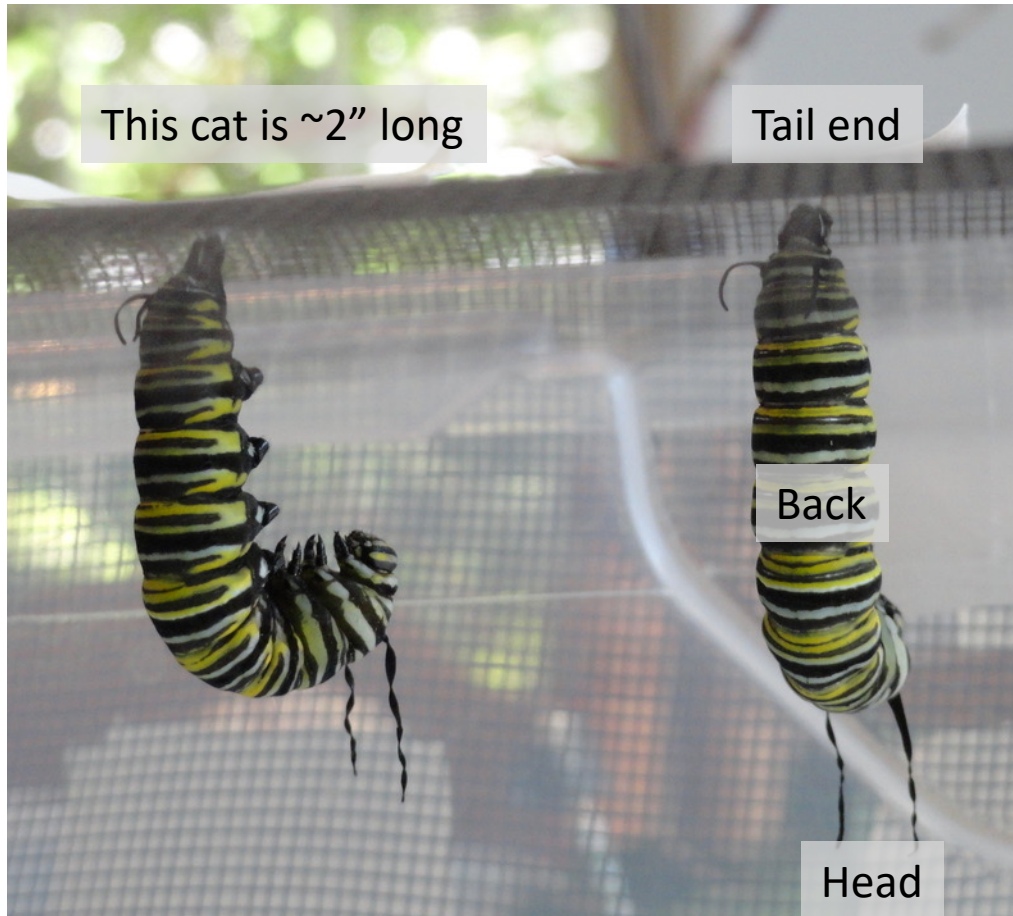
.... and therefore the chrysalis as well,



anywhere....

Monarch caterpillar behavior preparing to pupate

‘Wandering’ phase, find quiet place, make silk pad, hang upside down ‘J shape’ for 12-24 hr before turning into a chrysalis.



Cremaster: caterpillar ‘glues’ its last 2 prolegs into the silk pad to support its weight and hang upside ‘J shape’

Monarch's pupation: caterpillar to chrysalis (dorsal view)

1 to 8: ~ 30 min, 8 to 9: ~ 2 hours, 9-10: ~ 1 week



Monarch's pupation: caterpillar to chrysalis (ventral view)

1 to 8: ~ 30 min, 8-9: ~ 2 hours

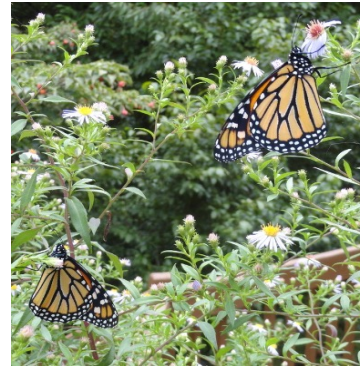


Monarch's eclosion: chrysalis to adult butterfly

1 to 3: ~1.5 min, 4 to 8: ~13 min, from 9-10 to flying: several hours



Wings drying out for several hours after eclosion



Differentiating male and female monarch butterflies

Males: 2 black spots on hind wings, thin black webbing within the wings

Females: no black spots on hind wings, thick black webbing within the wings



Male



Female

Adult monarchs sipping nectar from different flowers



But... isn't Milkweed a Toxic Plant?! Yes!

Many plants and animals contain natural products that are toxic

- These natural plant products/chemicals act as 'repellants' to protect themselves against predators
- The chemicals are often toxic, because they 'fit' on animal and human receptors or enzymes and can therefore either block or over-stimulate the 'normal' activity of the endogenous hormone or endogenous transmitter
- Sometimes these chemicals can be used as human medications: well-known examples are: morphine (acts on the opioid receptor), nicotine (acts on the acetylcholine receptor), digoxin (acts on the sodium-potassium pump)
- All milkweed plant species contain natural, but toxic chemicals called 'cardenolides'
- *Aspecioside*: main cardenolide found in milkweed plants (leaves, flowers and nectar)
- *Aspecioside* is also toxic to monarch caterpillars: ~60% of young monarch caterpillars die after taking their first few bites from milkweed leaves

Co-Evolution of Monarchs and Milkweed Plants (1)

- Reciprocal adaptation and long ‘co-evolutionary’ history (350 million years): monarchs evolved to ‘tolerate’ milkweed chemicals
- Milkweed plant is the *ONLY* host plant for monarch butterflies
- Monarch females deposit their eggs *ONLY* on milkweed plant and caterpillars eat *ONLY* milkweed leaves



Co-Evolution of Monarchs and Milkweed Plants (2)

- Monarch butterflies must sequester milkweed plant cardenolides for their own defense mechanism
- It gives them bright colors, indicating:
I AM TOXIC! (= 'aposematic coloration')
- Females seem to decide on which milkweed plant to lay her eggs by assessing the risk of chemical toxicity vs. exposure to predation
- Females choose small, recently sprouted milkweed plants: intermediate level of cardenolides (high sequestration of cardenolides, aposematic coloration) and high survival rate of hatching caterpillars through the end of the 1st instar



*From: 'Monarchs and Milkweed'
by Anurag Agrawal (2017)*

Aposematic* coloration strategy = ‘Warning!’ to predator

A white-yellow-black-striped caterpillar and an white-orange-black adult butterfly packed with toxic cardenolides from milkweed plants (effective for birds, not invertebrates)



* Aposematic (/ˌapəseˈmadɪk/) = bright coloration or markings to warn or repel predators

Co-Evolution of Monarchs and Milkweed Plants (3)

How do they survive milkweed toxicity...?

By developing survival strategies:

- Young caterpillars bite circles in the leaf to drain the latex (the leaf has holes)
- Older caterpillars cut off the flow of latex at the leaf notch (leaf hangs down)

The amount of latex (i.e. the white 'glue' containing cardenolides) is different in different milkweed species:

High - *A. californica*, *A. lemmonii*

Low - *A. incarnata*, *A. exaltata*

Intermediate - *A. syriaca* (common milkweed)



Cardenolides are Cardiac glycosides

All milkweed species contain 'cardenolides' ('cardiac glycosides')

- They have pharmacological effects on the animal heart
- Monarchs evolved the physiological adaptations to 'tolerate' these chemicals (~300 x lower sensitivity for cardenolides)

Several other plants also contain 'cardiac glycosides':

- dogbane, oleander, periwinkle, frangipani, swallow-wort, foxglove (*Digitalis purpurea*)
- Foxglove contains the 'cardiac glycosides': digoxin and digitoxin
- Cardiac glycoside in Foxglove (*Digitalis purpurea*): digoxin and digitoxin are therapeutic medications to treat human heart conditions (congestive heart failure, arrhythmias, FDA approved)
- Digoxin and Digitoxin (and Aspecioside) act on a heart enzyme (sodium-potassium ATPase or 'sodium pump'), present in all animal cells, including insects (monarch butterflies)
- Apecioside (in milkweed), digoxin and digitoxin (in foxglove) have comparable chemical structures and pharmacological profiles

The milkweed plant community (caterpillars)



Monarch butterfly
(*Danaus plexippus*)
on *A. incarnata*



Dogbane moth
(*saucrobotys futilaris futilaris*)
on *A. incarnata*



Tussock moth
(*Euchaetes egle*)
on *A. syriaca*

The milkweed plant community (bugs & beetles)



Large milkweed bug (*Oncopeltus fasciatus*)



Small milkweed bug (*Lygaeus kalmia*)

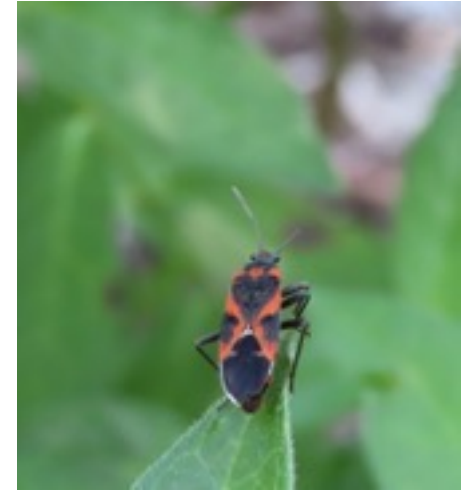


Red milkweed beetle (*Tetraopes tetraophthalmus*)



Milkweed bug nymphs (Hemiptera) in various stages

Aposematic coloration: seed-eating milkweed insects



Lygaeus kalmia



Tetraopes tetraophthalmus

Cryptic visual strategy = blend in the natural setting and provide crypsis*

Chrysalis undergoing metamorphosis: jade green color with gold spots and ring



* Crypsis = ability to avoid observation or detection by other animals

The Plants: Garden diversity and 'insect magnet' plants

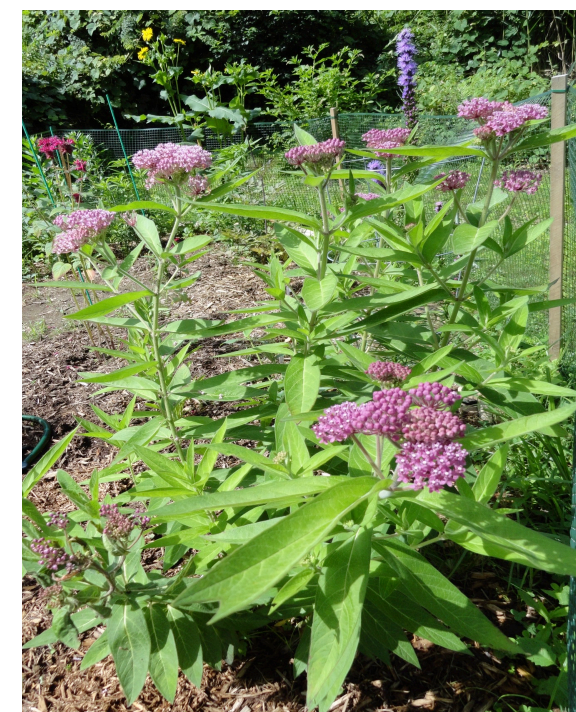
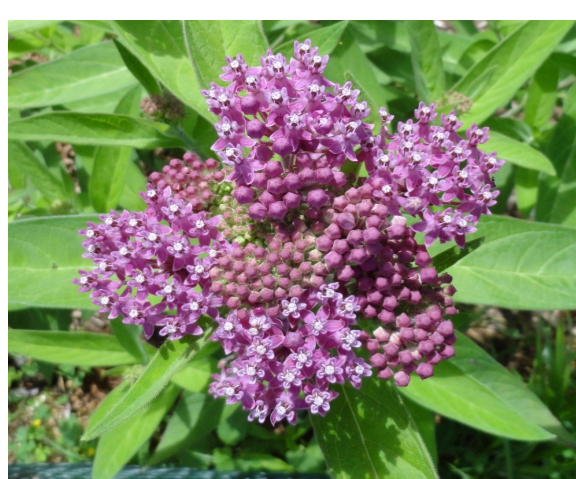
- Milkweeds: red/swamp, common, tuberosa
- Anise hyssop (Agastache)
- Monardas (native & cultivar)
- Joe Pye weed
- Blazing star/Liatris
- Smooth Penstemon
- Mountain mint
- Cardinal flower, Great blue lobelia, Ironweed, Onions, Spiderwort
- Asters & Goldenrods
- Blue Mistflower
- Rudbeckias & Helianthus
- New Jersey tea



Common milkweed
(*A. syriaca*)

Butterfly milkweed
(*A. tuberosa*)

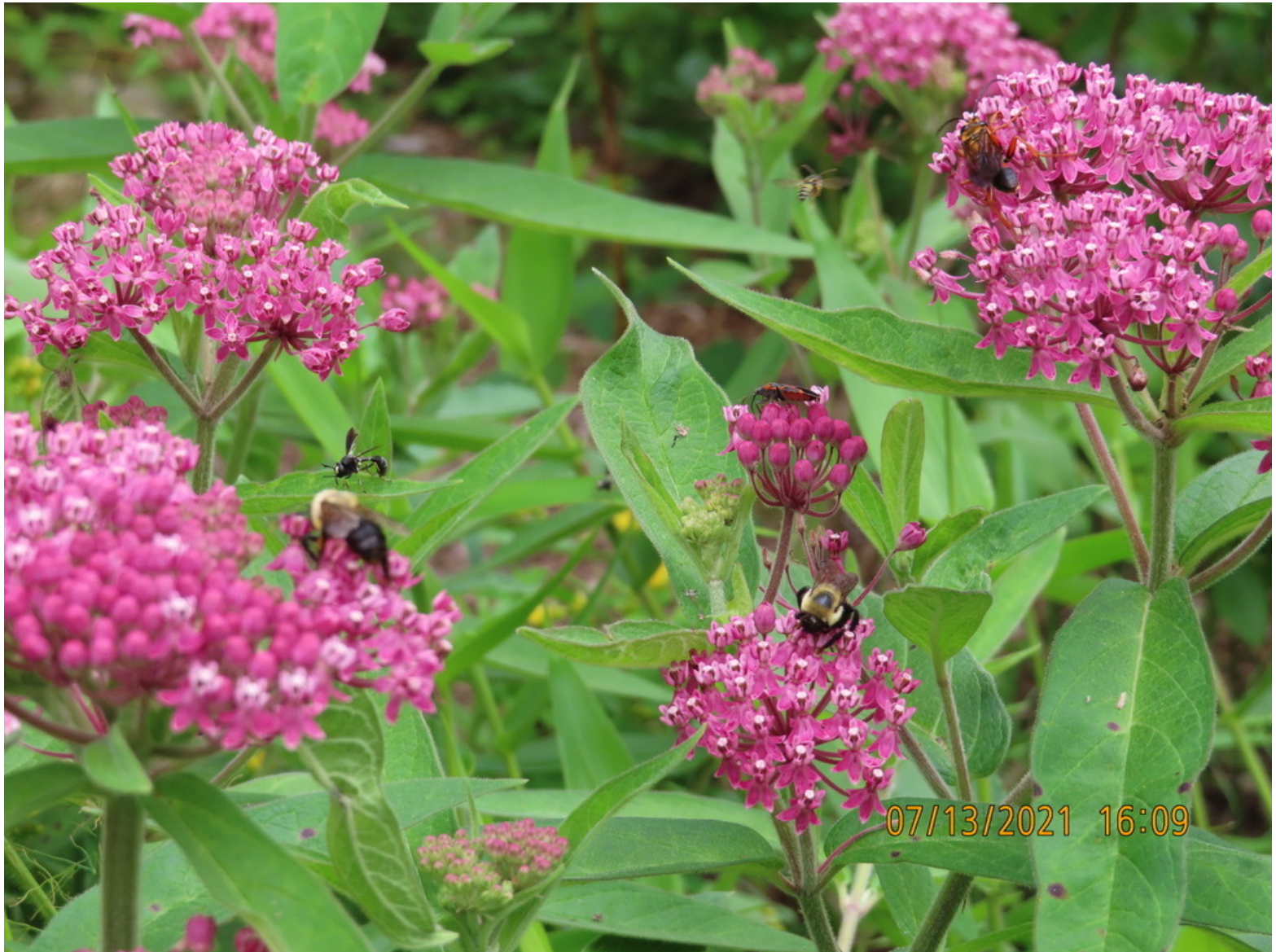
Butterfly milkweed 'Ice ballet'
(*A. incarnata*)



Swamp milkweed (*A. incarnata*)
Garden Club sale

Red milkweed (*A. incarnata*)
Prairie Nursery

Swamp milkweed (*A. incarnata*)





Lavender Hyssop (*Agastache foeniculum*)

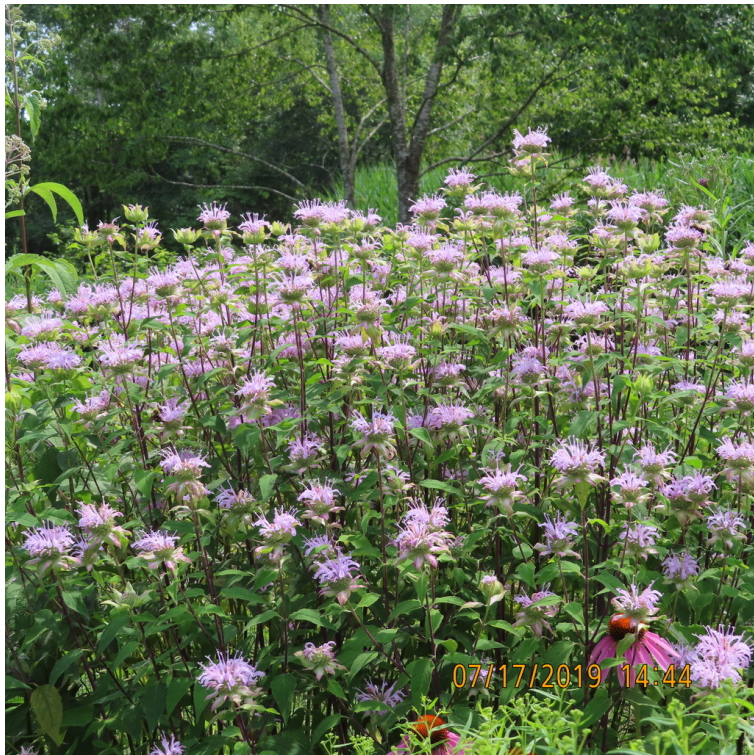
Monardas



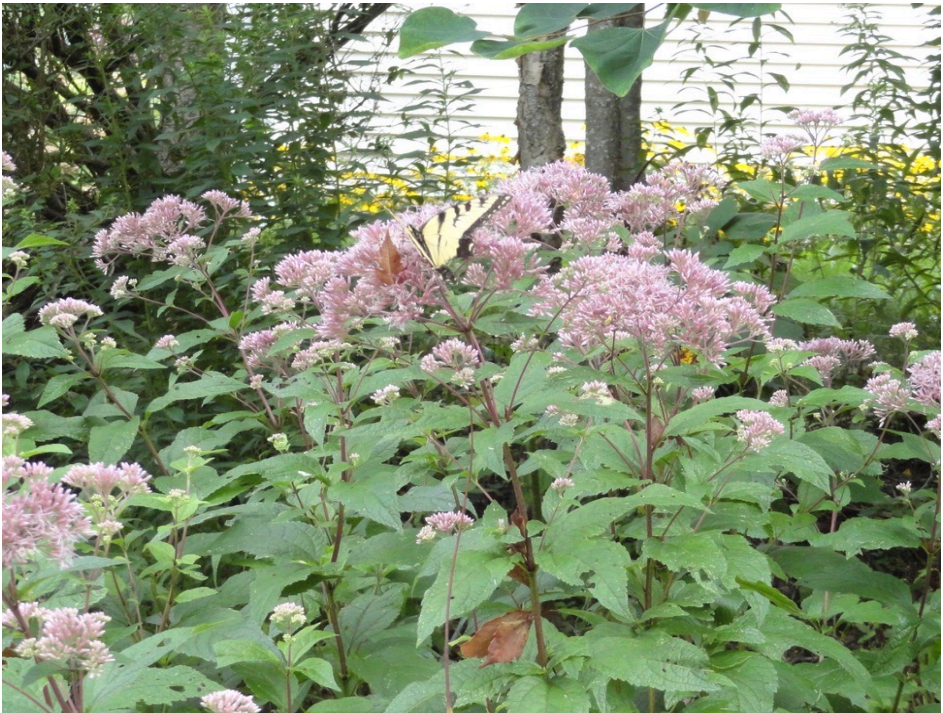
Bee balm 'Monarda didyma'

Bee balm 'Jacob Cline'

Bee balm 'Marshall's Delight'



Bergamot (*Monarda fistulosa*)



Sweet Joe Pye Weed (*Eutrochium purpureum*)



Spotted Joe Pye Weed (*Eutrochium maculatum*)



Short-toothed mountain mint (*Pycnanthemum muticum*)

Blazing stars/Liatris

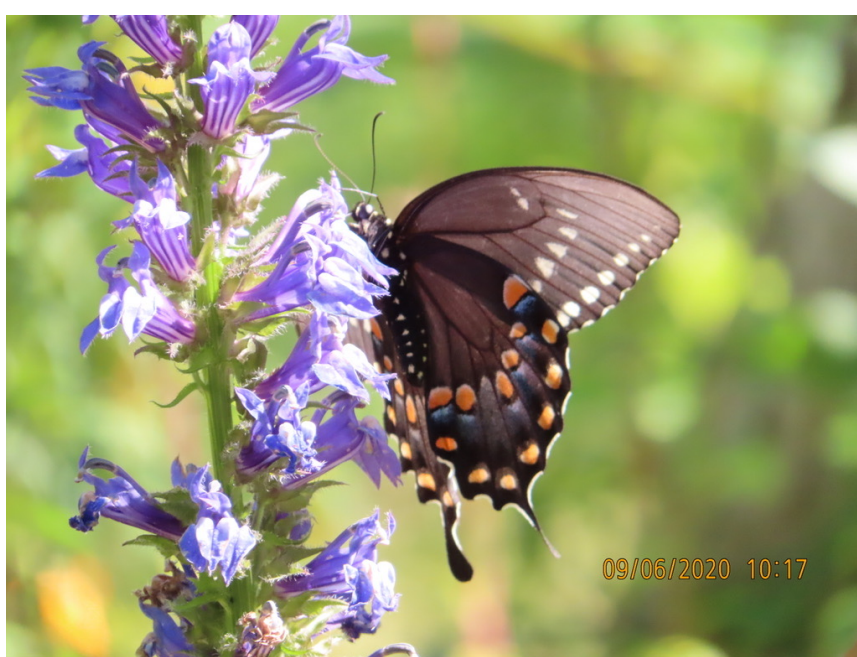




Cardinal flower
(*Lobelia cardinalis*)

Ironweed
(*Vernonia fasciculata*)

Smooth penstemon
(*Penstemon digitalis*)



Great blue lobelia (*Lobelia siphilitica*)



Ohio spiderwort (*Tradescatia ohiensis*)

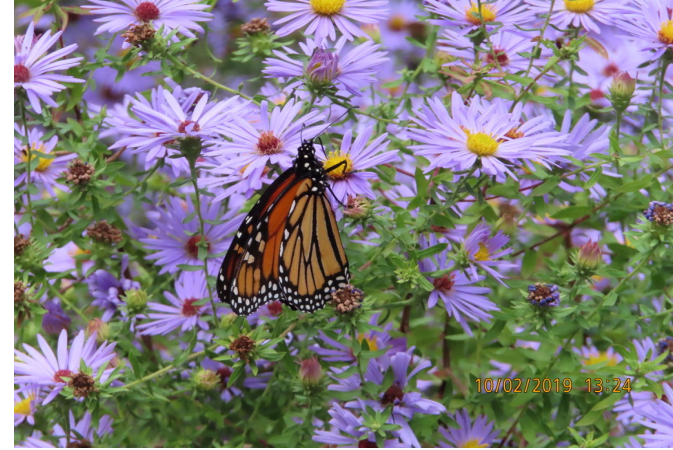


Nodding pink onion (*Allium cernuum*)



Boneset (*Eupatorium perfoliatum*)

Asters



Stoke's Aster (*Stokesia laevis*, purple, white)

Hardy Aster (*Aster oblongifolius*)

Asters



New England Aster
(*Aster novae-angliae*)

Smooth Aster
(*Aster laevis*)

Crooked Stem Aster
(*Aster prenanthoides*)

Goldenrods



Ohio goldenrod
(*Solidago ohioensis*)



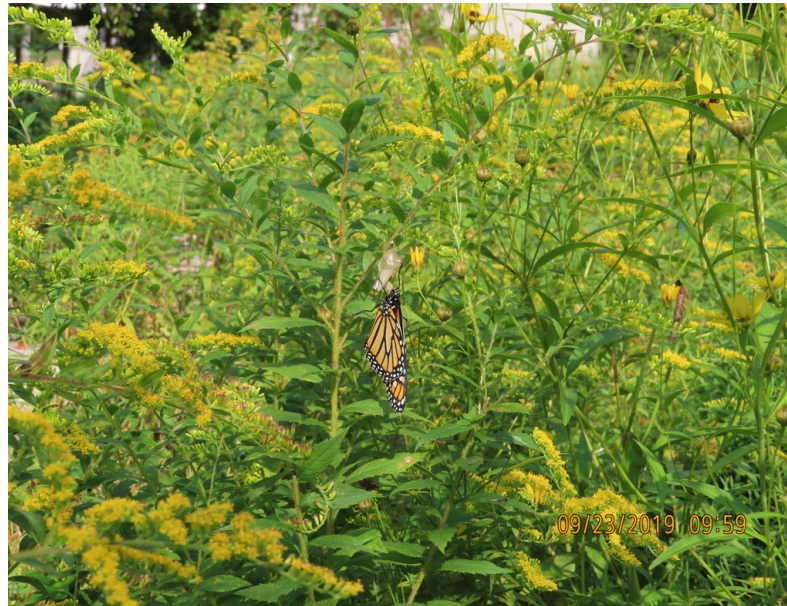
Wild goldenrod (*Solidago* sp.)



Stiff goldenrod (*Solidago rigida*)



Goldenrod 'Fireworks'
(*Solidago rugosa*)



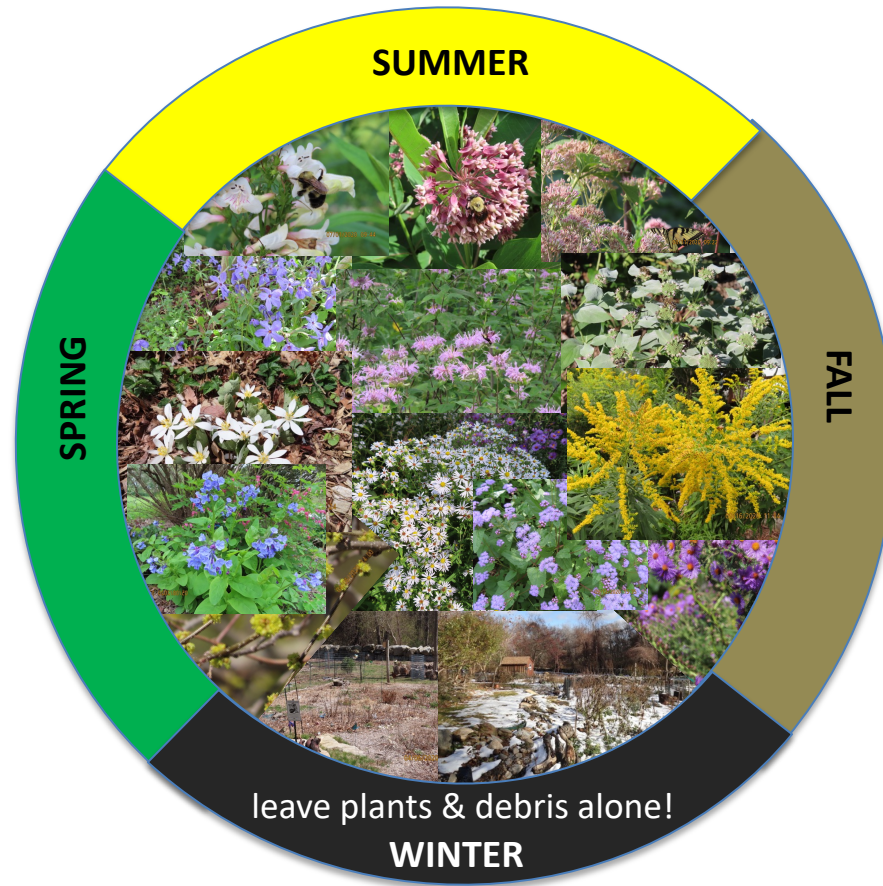
Lance-leaved goldenrod
(*Euthamia graminifolia*)

Monarch Migration Corridor: 10/02/2019



Monarchs sipping nectar on Blue Mistflower (*Eupatorium coelestinum*)

The native garden plants should provide:
ALL SEASONS BUFFET



View of backyard garden borders (November)



Resources & Information

National Wild Ones: Native Plants Bring Pollinators and Birds and Increase Biodiversity of Your Garden www.wildones.org

Native Garden Design section of Wild Ones
<https://nativegardendesigns.wildones.org/>

Connecticut Chapter Wild Ones website
<https://mountainlaurel.wildones.org/>

Pollinator Pathway
<https://www.pollinator-pathway.org/>

CT Botanical Society
<https://www.ct-botanical-society.org/>

Native Plants of North America
<https://www.wildflower.org/plants-main>

The Xerces Society for Invertebrate Conservation
<https://www.xerces.org/>

iNaturalist
<https://www.inaturalist.org>

Want to know more about Wild Ones and native plants?

Email: wild.native.plants@gmail.com

Find CT Chapter Wild Ones on Facebook: Mountain Laurel (CT) Chapter

Join Wild Ones at: <https://wildones.org>

The Mountain Laurel (Connecticut) Chapter is based in New London (CT) and sponsored by the Connecticut College Arboretum.



MOUNTAIN LAUREL (CONNECTICUT) CHAPTER

A close-up photograph of several tall, dark-stemmed plants with clusters of small, light pink flowers. Several bees are visible on the flowers, including a prominent one in the center. The background is a blurred garden setting with green foliage and a stone path.

Thank you
for your
attention!